NATIONAL SCIENCE FOUNDATION
4201 WILSON BOULEVARD
ARLINGTON, VIRGINIA 22230

OFFICE OF THE
ASSISTANT DIRECTOR
FOR ENGINEERING

March 8, 2010

Dr. Steven P. Castillo
Colorado School of Mines
Academic Affairs
1500 Illinois Street
Golden, CO 80401

Dear Dr. Castillo:

The Division of Civil, Mechanical & Manufacturing Innovation's (CMMI) Committee of Visitors Report was previously transmitted by Dr. Tresa Pollock, Chair of the COV. We thank you and the COV members for support of the NSF CMMI programs.

I have attached a response to the recommendations in the CMMI COV report that was prepared by Dr. Steven H. McKnight, Director of the Division of Civil, Mechanical & Manufacturing Innovation. I concur with this document and hereby adopt it as the official response of the Directorate for Engineering.

I wish to express my appreciation to the individuals who participated in the COV review. This process is critical to the management of the Directorate, and will help to guide our future decision-making.

Sincerely,

Thomas W. Peterson
Assistant Director
Directorate for Engineering

Directorate for Engineering Advisory Committee
Membership
Fall '09

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Steven P. Castillo Colorado School of Mines Academic Affairs 1500 Illinois Street Golden, CO 80401 Steven.castillo@is.mines.edu 303-273-3327 *Term: Fall '07 – Spring '10*	Patrick V. Farrell Provost and Vice President for Academic Affairs Lehigh University 27 Memorial Drive, West Bethlehem, PA 18015-3035 farrell@engr.wisc.edu (601) 758 3605 *Term: Spring '09 – Fall '12*
Wesley L. Harris Associate Provost for Faculty Equity Charles Stark Draper Professor of Aeronautics and Astronautics Massachusetts Institute of Technology Building 4-250 Cambridge, Massachusetts 02139 weslhar@MIT.EDU 617-258-7390 - Department 617-253-0911 - Office *Term: Fall '09 – Spring '10* *CEOSE Liaison for ENG AC*	Tom Knight Founder and CEO Invistics Corporation 5185 Peachtree Parkway, Suite 390 Norcross, Georgia 30092 tknight@invistics.com 770-559-6386 *Term: Fall '08 – Spring '11* *SBIR/STTR Advisory Committee Chair*
Margaret Murnane Fellow at Joint Institute for Laboratory Astrophysics Department of Physics and Electrical and Computer Engineering University of Colorado at Boulder Boulder, Colorado 80309-0440 murnane@jila.colorado.edu 303-492-7839 – Office *Term: Fall '06 – Spring '10* *Advisory Committee Chair, Fall '08 – Spring '09*	Tresa M. Pollock L.H. and F.E. Van Vlack Professor Materials Science & Engineering University of Michigan 2300 Hayward St. HH Dow 2042 Ann Arbor, Michigan 48109 tresap@engin.umich.edu 734-615-5150 - Office *Term: Fall '08 – Spring '11*

Gregory Washington Professor and Associate Dean of Research College of Engineering The Ohio State University 161 Hitchcock Hall 2070 Neil Ave Columbus, Ohio 43210-1275 washington.88@osu.edu (614) 292-2986 - Office *Term: Fall '07 – Spring '10*	William A. Wulf University Professor Dept. of Computer Science University of Virginia Charlottesville, Virginia 22901 wulf@virginia.edu 434-982-2223 Office *Term: Fall '07 – Spring '10*

MEMORANDUM

DATE: March 8, 2010

TO: Thomas W. Peterson, AD/ENG

FROM: Steven H. McKnight, DD/CMMI

SUBJECT: Division Report on Diversity, Independence, Geographic Balance, and Resolution of Conflicts for the CMMI COV

This report to you is on the diversity, independence, geographic balance, and resolution of conflicts of the Committee of Visitors (COV) for the Division of Civil, Mechanical & Manufacturing Innovation (CMMI), held June 24-26, 2009.

The COV, which was assembled to review the CMMI Division and whose report was presented to the Engineering Advisory Committee during the October 21-22, 2009 meeting, consisted of thirteen persons, of whom ten were male and three female. Two of the members were African-American. One member was from an EPSCoR state. The geographic balance had five members from Eastern states, five from Central states, one from a Mountain state, and two from Pacific states.

Eleven of the COV members were from academia and two from Government. One of the academic members was from an Undergraduate Institution. The Chair of the COV was female and at the time was the LH. and F.E. Van Vlack Professor at the University of Michigan, and was a member of the Engineering Advisory Committee. The Co-Chair was Caucasian male and is the chief of and a supervisory physical scientist in the Precision Engineering Division (PED) of the Manufacturing Engineering Laboratory (MEL) at the National Institute of Standards and Technology (NIST). All of the members from academia were at the rank of Professor. One was a Dean and two were Department Chair at their respective institutions. Several other members from academia held endowed chair positions at their respective institutions and one was retired. One government member was the Division Chief of a federal agency laboratory and the other a distinguished member of the technical staff of a federal agency laboratory. Their backgrounds represented a variety of disciplines in science and engineering relevant to CMMI. One invited COV member from industry did not attend the meeting.

Six of the thirteen members were not at the time of the COV meeting serving on any NSF Advisory Committees and had not been applicants to the CMMI programs under review for at least five years. None had proposals pending with CMMI during the COV meeting. A conflict of interest briefing was held on the first day of the COV meeting and all completed the NSF Conflict of Interest form. No member disclosed any conflicts. Assignments were made to ensure that there would be no potential conflicts of interest. No real or apparent conflicts arose during the course of the meeting.

DIRECTORATE FOR ENGINEERING

MEMORANDUM

DATE: May 1, 2009

TO: 2009 Civil, Mechanical and Manufacturing Innovation Division Committee of Visitors

CC: Dr. Margaret Murnane, Chair of the Engineering Advisory Committee
Dr. Michael Reischman, Deputy Assistant Director for Engineering
Dr. Bruce Kramer, Acting Division Director for Civil, Mechanical and Manufacturing Innovation

FROM: Dr. Thomas Peterson, Assistant Director for Engineering

SUBJECT: Charge to the CMMI Committee of Visitors

Thank you for agreeing to serve on the Committee of Visitors (CoV) for the Division of Civil, Mechanical and Manufacturing Innovation (CMMI) of the Engineering Directorate of the National Science Foundation (NSF). By NSF policy, programs that award grants or cooperative agreements are reviewed at three-year intervals by a CoV. The CoV is an *ad hoc* subcommittee of the Advisory Committee for the Directorate for Engineering. Dr. Tresa Pollock, who will serve as the CoV Chair, is a member of the Advisory Committee, and Dr. Postek will serve as CoV Vice Chair. The CoV reviews the proposal and award process, advises ENG on significant impacts and advances from CMMI investments, and identifies emerging challenges and opportunities.

The CoV charge is to address:

- The integrity, efficacy, and quality of the processes used to solicit, review, recommend and document proposal actions;
- The quality of project management, monitoring, and evaluation of funded proposals.
- The quality and significance of the results of the Division's programmatic investments in terms of program, division, and NSF-wide goals;
- The Division's balance, priorities, and strategies for realizing the potential of the Division (as background, please refer to the most recent CMMI plan, the Directorate's plan for broadening participation, and the NSF FY 2006-2011 Strategic Plan, and
- Any other issues you think are relevant to the review.

This CMMI CoV shall use the attached NSF 2009 Core Questions and Report Template in preparing its report as provided on the CMMI CoV web page.

Decisions to award or decline grant proposals are based on the informed judgment of program officers and the Division Director following merit review. Systematic examination of proposal files by qualified

external parties provides an independent mechanism of monitoring and evaluating the quality and pertinence of proposal decisions. This examination is part of the responsibility of the CoV.

The review will assess the operations of the CMMI Division in fiscal years 2006, 2007 and 2008 as they support the Foundation's strategic outcome goals regarding **discovery, learning, and research infrastructure**. The CoV will examine a sample of files for both awarded and declined proposals in each program. The CoV will also examine a sample of proposals that were returned without review to determine the extent and appropriateness of the Division's enforcement of the Grant Proposal Guide requirements on proposal submission.

The activities of the CMMI Division are organized into four clusters as noted ~~in noted~~ on the CMMI CoV web page. The Division also provides oversight for interdisciplinary NSF and Engineering priorities, such as Nano Science and Engineering Centers (NSEC), Engineering Research Centers, awards for Materials Use: Science, Engineering and Society, Human and Social Dynamics, and Sensors and Sensor Networks.

The review of jackets for this CoV will be accomplished through eJacket, and we would like all committee members to complete their review of the electronic jackets by June 23rd. The information that you will need to perform this review is conveniently accessible through the CMMI CoV web site. You will be given electronic access to a sampled set of proposal actions, and you may request access to additional actions as you deem necessary. Also, you will have access to the CMMI Division Director, Deputy Division Director and Program Directors for additional information.

The meeting of the CoV will take place Wednesday through Friday, June 24-26, 2009, at the Honolulu Convention Center, Honolulu, Hawaii, concurrent with the 2009 CMMI Grantees Conference. An initial briefing of the CoV will take place by teleconference on May 5, 2009. Specific assignments will be given to the CoV members at that time. The CoV will convene next at 11:00 AM at the Honolulu Convention Center (rooms to be announced at the May 5 teleconference), and will adjourn when finished on Friday, June 26, 2009 after briefing me on the essence of the CoV's findings.

Not later than July 15, 2009, the CoV should transmit its report addressing the charge the Chair of the Engineering Advisory Committee (AdCom), for review. The report will be discussed at the fall, 2009 AdCom meeting. The AdCom chair will forward the report to me with any comments from the Engineering Advisory Committee. In accordance with NSF policy, the Directorate will provide a response setting forth any actions to be taken on each suggestion or recommendation. Both the CoV report and the response will be forwarded to the Director of the NSF, and ultimately posted on the NSF web site (http://www.nsf.gov/eng/general/cov/).

We very much appreciate your service in this important NSF activity, and we hope that you will find the process both interesting and informative.

COLORADOSCHOOLOFMINES
EARTH • ENERGY • ENVIRONMENT

OFFICE OF ACADEMIC AFFAIRS

December 9, 2009

Dr. Thomas W. Peterson
Assistant Director of Engineering
The National Science Foundation
4201 Wilson Blvd.
Arlington, VA 22230

Dear Dr. Peterson:

On behalf of the Engineering Advisory Committee, I am pleased to present you with the 2009 COV reports for the Division of Chemical Bioengineering, Environmental and Transport Systems (CBET) chaired by Dr. Matthew Tirrell and the Division of Civil, Mechanical, and Manufacturing Innovation chaired by Dr. Tresa M. Pollock. Both program chairs gave brief presentations at the fall, 2009 AdCom meeting in Washington DC with the results of those presentations being integrated into the AdCom's comments back to you and Dr. Bement.

Please let me know if you have any questions or comments regarding the reports.

Sincerely,

Steven Castillo
Provost and Executive Vice President

CORE QUESTIONS and REPORT TEMPLATE
for
FY 2009 NSF COMMITTEE OF VISITOR (COV) REVIEWS

Guidance to NSF Staff: This document includes the FY 2009 set of Core Questions and the COV Report Template for use by NSF staff when preparing and conducting COVs during FY 2009. Specific guidance for NSF staff describing the COV review process is described in Subchapter 300-Committee of Visitors Reviews (NSF Manual 1, Section VIII) that can be obtained at <www.inside.nsf.gov/od/oia/cov>.

NSF relies on the judgment of external experts to maintain high standards of program management, to provide advice for continuous improvement of NSF performance, and to ensure openness to the research and education community served by the Foundation. Committee of Visitor (COV) reviews provide NSF with external expert judgments in two areas: (1) assessments of the quality and integrity of program operations and program-level technical and managerial matters pertaining to proposal decisions; and (2) comments on how the results generated by awardees have contributed to the attainment of NSF's mission and strategic outcome goals.

Many of the Core Questions are derived from NSF performance goals and apply to the portfolio of activities represented in the program(s) under review. The program(s) under review may include several subactivities as well as NSF-wide activities. The directorate or division may instruct the COV to provide answers addressing a cluster or group of programs – a portfolio of activities integrated as a whole – or to provide answers specific to the subactivities of the program, with the latter requiring more time but providing more detailed information.

The Division or Directorate may choose to add questions relevant to the activities under review. NSF staff should work with the COV members in advance of the meeting to provide them with the report template, organized background materials, and to identify questions/goals that apply to the program(s) under review.

Suggested sources of information for COVs to consider are provided for each item. As indicated, a resource for NSF staff preparing data for COVs is the Enterprise Information System (EIS) –Web COV module, which can be accessed by NSF staff only at http://budg-eis-01/eisportal/default.aspx. In addition, NSF staff preparing for the COV should consider other sources of information, as appropriate for the programs under review.

Guidance to the COV: The COV report should provide a balanced assessment of NSF's performance in two primary areas: (A) the integrity and efficiency of the ***processes*** related to proposal review; and (B) the quality of the ***results*** of NSF's investments that appear over time. The COV also explores the relationships between award decisions and program/NSF-wide goals in order to determine the likelihood that the portfolio will lead to the desired results in the future. Discussions leading to answers for Part A of the Core Questions will require study of confidential material such as declined proposals and reviewer comments. *COV reports should not contain confidential material or specific information about declined proposals.* Discussions leading to answers for Part B of the Core Questions will involve study of non-confidential material such as results of NSF-funded projects. The reports generated by COVs are used in assessing agency progress in order to meet government-wide performance reporting requirements, and are made available to the public. Since material from COV reports is used in NSF performance reports, the COV report may be subject to an audit.

We encourage COV members to provide comments to NSF on how to improve in all areas, as well as suggestions for the COV process, format, and questions. For past COV reports, please see http://www.nsf.gov/od/oia/activities/cov/covs.jsp.

FY 2009 REPORT TEMPLATE FOR NSF COMMITTEES OF VISITORS (COVs)

The table below should be completed by program staff.

Date of COV: Friday, June 26, 2009
Program/Cluster/Section: All
Division: Civil, Mechanical, and Manufacturing Innovation
Directorate: Engineering
Number of actions reviewed: **Awards: 120** **Declinations: 111** **Other: 9**
Total number of actions within Program/Cluster/Division during period under review: **Awards: 1436** **Declinations: 6612** **Other: 223**
Manner in which reviewed actions were selected: CMMI staff queried the NSF proposal database to obtain a list of all proposals received between 06/30/2005 and 06/30/2008. These dates represent the window in which the proposals processed between FY 2006 and FY 2008 were received. After obtaining this list, the following actions were removed from the data set for sampling: 1. Withdrawn proposals; these have a record of receipt, but were withdrawn by the PI before any action was taken. 2. Special Initiatives and trans-directorate program proposals managed by CMMI (e.g. Major Research Infrastructure (MRI) and Cyber Enabled Discovery & Innovation (CDI) proposals). Proposals from these programs are reviewed by their own Committees of Visitors. 3. Intergovernmental Personal Assignment Awards (IPAs) – NSF Program Staffing Actions that are not subject to this COV. The remaining proposals were then sorted by ownership amongst the four CMMI research program clusters. Proposals were then sorted by type (Unsolicited Proposals, CAREER, other) and then by award status and proposal number. Ten percent of each group was selected for COV administrative review. The first proposal in each group was selected along with the next proposal, which represented the ten percent figure. For example, 39 CAREER awards were made in the SED Cluster, therefore when organized in a spreadsheet; every fourth proposal represented 10 percent.

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question**.** Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	**YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[1]**
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: Review methods were appropriate to the nature of each proposal (such as CAREER, standard research proposal, workshop support). Research proposals received critical review by experts in the field while classes of grants (e.g. SGER and workshops) that did not require panel review were appropriately evaluated by program directors.	Yes
2. Are both merit review criteria addressed a) In individual reviews? b) In panel summaries? c) In Program Officer review analyses? Comments: The panel reviews uniformly addressed the first criterion, but occasionally	Yes

[1] If "Not Applicable" please explain why in the "Comments" section.

reviewers did not address the second. Further, panelists tended to write more extensively and intently when addressing the first than when addressing the second. Most panel summaries integrated appropriately the comments of the reviewers with respect to both criteria. In almost every case, there were sufficient comments from reviewers that the panel summary addressed both criteria. Exceptions occurred where panelists found significant technical issues with the first criterion so that addressing the second seemed unnecessary. The program director analysis almost always addressed both issues. Exceptions to this were the same that occurred with the panel summaries. The COV has two recommendations in this regard: 1. The program directors must insist strenuously that reviewers address both criteria. 2. The program directors must similarly insist that annual reports address the second criterion with sufficient depth.	

3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: The vast majority of the individual review comments were substantive and indicated a detailed understanding of the proposal. Those reviewers that followed the questions outlined by NSF for each review criterion in general did a more comprehensive job. The COV felt that substantive comments regarding the broader impacts criteria are more difficult for panelists to address. The COV recommends that program officers prompt panelists to give more substantive comments, e.g., • What is missing from the proposal? • What additional information would you need to give the proposal a higher rating? • What would persuade you to give the proposal a higher rating? • What standards are you using to rate this proposal? • What are the elements of the proposal that most strongly support your recommendation? • Why is this important?	Yes
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)?	Yes

Comments: Generally, panel summaries did provide the rationale for the consensus that was reached. In the jacket a better explanation of how the reviewers' scores (E, V, G, F) relate to the panel summary could be provided. In cases where there was small variation among the individual assessments the panel summary recommendations were clear (and the text supported the panel assessment); when individual grading varied considerably among the panelists, that was not the case. In most cases, the panel summaries provide adequate rationale for the panel consensus and where there are differences of opinions among reviewers, the panel summary often does not provide insight on these differences.	
5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) Comments: Overall the documentation in the jackets does provide the rationale for the decisions made, with the review analysis written by the Program Officer providing the best documentation. However, the COV noted a few cases (5 out of 265) where the documentation appears weak; the reversal of a declination is not in the jacket, a declination of a Conference (CONF) proposal due to budgetary constraints could have been better explained and, a declination made on the basis of a face-to-face discussion of only two panelists could have been better managed.	Yes

6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) Comments: In general, the documentation adequately explains the rationale for the decisions. However the COV noted a few inconsistencies in the level of review and analysis provided to the PI's for the decision. The analyses provided for the SGER, CONF and CAREER proposals were comprehensive and conveyed a clear rationale for the decisions made. The PI's of the unsolicited proposals in some instances were not provided with as comprehensive an analysis on a consistent basis. A better job could be done in providing the PI's with meaningful feedback on technical weaknesses and the addressing of the lack of discussion of broader impacts of the proposal. The COV notes that the Program Officer analysis and communication with the PI are very important and have generally been done very well.	Yes
7. Is the time to decision appropriate? Note: Time to Decision --NSF Annual Performance Goal: **For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later**. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. Comments: Yes, the target of having decisions made on 70% or more proposals within six months was met. Based on the jackets reviewed and data provided by the Division, decisions on most proposals were made within six months. However, there were some exceptions. In 2007 and 2008, in some programs a greater percentage of the proposal decisions exceeded the six months mark.	Yes

8. Additional comments on the quality and effectiveness of the program's use of merit review process:

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	**YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[2]**
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: In general the COV felt that the Program Directors chose very qualified panelists that were highly appropriate for the particular group of proposals being evaluated. Their knowledge in the area is documented in most cases by their own publications. In the case of reviewers from industry, one must deduce their level of expertise by the quality of the reviews – which is generally very good. The reviewers are generally of high quality and from peer institutions and research areas. There was good use of reviewers from multiple disciplines when the proposals were interdisciplinary. One specific example was a cross-disciplinary proposal where the panel appropriately included members with expertise in social science, sociology, economics, and geosciences. The COV believes there are areas of possible improvement. Several panels included a large number of fairly inexperienced junior faculty members. The program directors need to balance the benefit of bringing new reviewers into the system with having established researchers who may have a broader perspective and more experience. Multidisciplinary proposals create a challenge for the PD to include reviewers with appropriate areas of expertise. One example was noted where a panel of all civil engineers was used to review a proposal that included legal and business aspects. At least one reviewer with such expertise would have added value. The COV realizes that recruiting industrial reviewers for proposals is difficult. However, the COV reviewed a number of proposals that had a significant industry component, where industry was a partner or where the work being	Yes

[2] If "Not Applicable" please explain why in the "Comments" section.

proposed might have a significant industry impact, and yet there were no industry representatives on the panel. In the future, to assist with evaluation of the quality of the reviews, the COV believes that "self assessments" from reviewers on how qualified they think they are for any given proposal would be helpful.	
2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups? Note: Demographic data is self reported, with only about 25% of reviewers reporting this information. Comments: The program appears to achieve geographical balance and representation from a range of institution types. However, additional data on the available pool of researchers would be needed to evaluate whether the balance achieved is appropriate. With respect to under-represented groups, the COV observed within the group of sampled jackets, many panels included female members. However, a significant number of panels had no female panelists. There also appears to be little involvement of underrepresented minorities on panels, although it is recognized that the percentage of reviewers reporting their group status may be low. This may indicate that some program directors are missing a broad group of outstanding reviewers and should be an area of concern for NSF. The COV recommends that if the demographics of the panels do not broadly represent the demographics of available qualified reviewers, that the program officer document the reasons for this.	Insufficient information/No
3. Did the program recognize and resolve conflicts of interest when appropriate? Comments: In general, the conflict of interest issues were well addressed and resolved. In almost all cases, the Program Officer Review Analysis (PORA) provided adequate in-depth description of panelist views and the process with which decisions were made, not specifically addressing/reporting of the composition of the review panel and its implications on conflict of interest. However, two cases (2/265) with the appearance of a COI were noted. One involved a faculty member from the same institution reviewing a proposal and one had two panelists from the same department. There was inadequate documentation in both cases.	Yes

4. Additional comments on reviewer selection:

The issue of reviewer selection, particularly the appropriateness of reviewers in terms of the composition of reviewers for any proposal, their background and experience for the given project proposal area, along with any likely gender-based inclusiveness, etc., are somewhat difficult to judge from the evaluation of e-jackets and the relevant documentation posted.
The NSF gathers extensive demographic data (Science and Engineering Indicators; www.nsf.gov/statistics/seind08). The COV recommends that this data be used to evaluate balance.

The COV has a concern that some interdisciplinary proposals were not reviewed by interdisciplinary panels. If not addressed, with the anticipated increase of cross-disciplinary proposals, this could become an issue.

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[3], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. Comments: Overall, based on the expertise of the COV, the jackets studied and the available information at the CMMI Research and Innovation grantees conference, the quality of the projects supported was very high.	Yes
2. Does the program portfolio promote the integration of research and education? Comments: Yes, the portfolio of funded efforts demonstrated that this was a high-priority objective for this division and that the proposers clearly understand and address it. Not all panelists addressed this aspect in their reviews. Of those who did address it, several did not pay it as much attention as they paid the	Yes

[3] If "Not Appropriate" please explain why in the "Comments" section.

technical merit. Standards with respect to education are not clear; how does one evaluate (E, VG, G, …) the quality of proposed new courses and, say, the integration of undergraduates into research programs?	
3. Are awards appropriate in size and duration for the scope of the projects? Comments: The COV does not have a definition of what constitutes an "appropriate" sized award, but the general sense is that the award sizes were appropriate in the eyes of the individual committee members. Funding constraints resulted in reduced award sizes and, in some instances, the Program Officers negotiated reduced scope of work so the "Fund if possible" proposals could be funded with available money. However, further attention to grant sizes is probably required in light of the continuously increasing costs of conducting research. Reductions in requested funding levels should be justified on the basis of project scope rather than availability of funds.	No/insufficient information
4. Does the program portfolio have an appropriate balance of: • Innovative/potentially transformative projects? Comments: The COV finds that the program portfolio has an appropriate balance of innovative/potentially transformative projects. Program officers have all identified emerging research areas and have effectively used SGERs to support potentially high risk and high return projects.	Yes
5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? Comments: Overall, there appeared to be a good mix of interdisciplinary projects. In the group of sampled proposals, the COV found considerable evidence of collaborative research across disciplines. Moreover, it was clear that program directors actively sought funding from other programs to support outstanding proposals. The COV realizes that determining the "appropriate balance" is a subjective issue, but the division appears to be doing well in this area.	Yes

6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? Comments: The COV felt that this was a very difficult question to answer without a lot of statistical analysis of the entire CMMI portfolio. This analysis should have been provided to us. It may very well be available "on the web" but most of us could not find it. In general we felt that the balance was reasonable. The attention to CAREER awards and young investigators is very good. Individual PI grants continue to be supported. Workshops and NAE studies are used effectively.	Yes
7. Does the program portfolio have an appropriate balance of: • Awards to new investigators? NOTE: A new investigator is an investigator who has not been a PI on a previously funded NSF grant. Comments: Based on divisional data, the COV found that the balance of awards to new investigators is appropriate. It was noted that CAREER awards push the balance of awards in the direction of new investigators. New PI's who did not receive awards were given clear messages about the deficiencies in their proposals.	Yes
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments: While PIs from EPSCOR (Experimental Program to Stimulate Competitive Research) states may be underrepresented, the balance of geographical distribution of Principal Investigators appeared to be appropriate.	Yes

9. Does the program portfolio have an appropriate balance of: • Institutionnel types? Comments: While it is true that the number of awards to primarily undergraduate institutions is low, it is difficult to know what is appropriate. It is not clear to the COV how many research grant applications from these institutions were received. It may be better to assess this issue at a higher level of NSF.	Insufficient information
10. Does the program portfolio have an appropriate balance: ▪ Across disciplines and sub disciplines of the activity? Comments: CMMI is promoting cross-disciplinary projects, where appropriate. The program manager reports show vigorous activities to promote cross-disciplinary research.	Yes
11. Does the program portfolio have appropriate participation of underrepresented groups? Comments: Overall, the COV finds that the program portfolio documents participation of underrepresented minority (URM) groups. There is insufficient information to evaluate whether appropriate levels have been achieved in all URM groups. However, the participation of African Americans and Hispanics specifically is low and if it is much less than the pool of available participants, should be improved. There is plenty of room for improvement in the support of URMs; the Division and NSF should continue to develop and support new activities/programs that result in high quality proposals from URM investigators and institutions.	Yes
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments: The COV finds that the program's portfolio addresses important issues relating to national priorities, e.g., homeland security, nanotechnology, advanced manufacturing, aging infrastructure, advanced materials, sustainability, service enterprises and an educated workforce. These areas offer the US the opportunity for global competitiveness. The COV finds that CMMI is well focused on national priorities. NAE studies, such as those sponsored on Healthcare Delivery and Corrosion, are being	Yes

used effectively to develop future research challenges. The evolution in research support in the areas of energy and bioengineering is further evidence that current societal problems are impacting the portfolio of the program.	
13. Additional comments on the quality of the projects or the balance of the portfolio:	

A.4 Management of the program under review. Please comment on:

1. Management of the program.

Comments:

Management of the programs within the division is solid, balanced and professional. Proposal reviews were performed in a timely manner and decisions were communicated to the PIs within six months for well over 70% of the proposals. The division should continue to strive to increase the fraction of proposals processed within six months. In the majority of the proposals examined, the decisions were well documented and the jackets maintained very good and detailed record of the transactions associated with proposals throughout their life cycles. The division is responsive to the priorities of the country, is fostering emerging research areas and is committed to the development of a strong research base across a spectrum of institutions.

2. Responsiveness of the program to emerging research and education opportunities.

Comments:

The program is responsive to emerging research and education opportunities as evidenced through the program descriptions. The programs set strategic objectives based on national priorities (e.g., sustainability, energy) and follow strategies to attain these objectives. Workshops and small grants

for exploratory research have been used effectively for identification of emerging areas. Partnerships with other programs/divisions and government agencies have been entered to leverage on funding and expand opportunities. The mix of permanent and rotating program officers permits the division to address effectively new directions while maintaining involvement in long-term initiatives. The program officers keep abreast of new directions in education and emerging research and actively encourage researchers to propose unique and innovative ideas. Interdisciplinary projects are supported and programs within the division have experienced significant shifts in the sub-disciplines supported over time. Where appropriate, programs have been re-organized to be responsive to emerging opportunities; the Nano and Bio Mechanics program is a good example of this.

3. Program planning and prioritization process (internal and external) that guided the development of the portfolio.

Comments:

The priorities of the programs have been to support high quality research in emerging areas and areas critical to national needs. The portfolio of funded proposals appears to reflect these criteria. The programs appear to be well thought-out, engaged with current and emerging national priorities, and cognizant of global developments in science and engineering. The program planning and prioritization process involves considerable consultation with both internal and external groups and individuals through workshops, discussions with other program officers, national studies, and outreach programs. These mechanisms provide continuous improvement to the programs.

4. Responsiveness of program to previous COV comments and recommendations.

Comments:

The program appears to have responded positively to the recommendations of previous COVs, but there are some areas where the program still has not advanced as far as expected:

1. The CMS COV of 2004 recommended "To meet the challenge of increasing numbers of proposals, the COV recommends that additional staff be assigned to CMS at both the PD and support staff levels." Since then new staff have been hired, but insufficient to compensate adequately for attrition. Program Directors continue to appear to be overextended. This remains a concern.

2. The DMI COV of 2006 observed "Both the directorate and the DMI division should examine their strategic plans for consistency with the GPRA goals and make changes to align these strategic plans with the desired outcomes." We understand that a plan has been submitted and approved, but we have not seen evidence that the plan is referred to in the normal business practice.

3. Broader impact

    a. There is still no common understanding by the reviewers of how to judge the quality of potential broader impacts.

    b. The degree to which broader impact is achieved should be assessed – at least qualitatively.

4. The previous COV commented on there not being documentation in the jackets to assess the qualification of the reviewers. This issue might be resolved easily, through, for example, self-

assessments by reviewers.

5. The DMI COV of 2006 observed that the award size and duration were not appropriate. The COV has found no evidence of an analysis of the process for determining the appropriate size of awards.

5. Additional comments on program management:

The conversion to e-Jacket has made it considerably easier to monitor the review process.

The COV noted that in a few cases documentation was missing in the e-Jacket. For example, some diary notes were not uploaded.

PART B. RESULTS OF NSF INVESTMENTS

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The NSF mission is to:

- promote the progress of science;
- advance national health, prosperity, and welfare; and
- secure the national defense.

To fulfill this mission, NSF has identified four strategic outcome goals: Discovery, Learning, Research Infrastructure, and Stewardship. The COV should look carefully at and comment on (1) noteworthy achievements based on NSF awards; (2) ways in which funded projects have collectively affected progress toward NSF's mission and strategic outcome goals; and (3) expectations for future performance based on the current set of awards.

NSF investments produce results that appear over time. Consequently, the COV review may include consideration of significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when the investments were made.

To assist the COV, NSF staff will provide award "highlights" as well as information about the program and its award portfolio as it relates to the three outcome goals of Discovery, Learning, and Research Infrastructure. The COV is not asked to review accomplishments under Stewardship, as that goal is represented by several annual performance goals and measures that are monitored by internal working groups that report to NSF senior management.

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes ("highlights") as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

B.1 <u>OUTCOME GOAL for Discovery: "</u>*Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering."*

Comments:
The COV found that the research being done in the CMMI is significantly advancing the frontiers of knowledge. The following funded projects were identified as exemplary activities that support NSF goals for discovery. The summaries were developed from highlights collected by NSF from the PIs and are grouped according to cluster.

<u>Advanced Manufacturing</u>

- *0457503 Mark Daskin, Risk Management in Supply Chain Design and Operations, Northwestern University*

This project involves developing new risk management methods for supply chains that are critical to the success of industry in producing and distributing goods, to government in providing services, and to the military in deploying personnel and materiel to defend the country. This project addresses the increasingly complex supply chains due to increased outsourcing and globalization, and provides a means to achieve better efficiency through better utilization of

resources. The project considers threats to supply chain such as severe weather and natural disasters, which destroy plants and disrupt transportation lanes, business failures, labor strife, and terrorism. Also the disastrous effects of the 9/11 attacks, the contamination of the Chiron plant in Liverpool, producing half of the U.S. flu vaccine supply, and the aftermath of Hurricane Katrina are but a sample of the recent events that have significantly disrupted and impacted supply chains around the world. Robustness and reliability are considered as two major requirements to cope with such risks involved in supply chain operations. The project team has developed modeling techniques to design such supply chains. Increased supply chain reliability was shown as a result of hardening facilities to reduce the risk of a successful attack or disruption, and by developing alternate routes or sources of supply that are used in case of a disruption, increasing capacity and/or introducing production flexibility to mitigate supply disruptions, and buffering against supply and demand uncertainty by maintaining strategic inventories and reserves. In trading off facility costs and transportation costs, the principal investigators have identified two regimes of the facility hardening cost/facility reliability space. In one regime, it is optimal to employ both hardened and non-hardened facilities. For larger facility failure probabilities, only hardened facilities should be used. In other work, it is shown, for some types of unreliability, that there is a tradeoff between efficiency and disruption cost in the design of flexible facilities to protect against uncertain demand. The ultimate goal of this research is to identify strategies that mitigate supply chain risk in a cost effective manner.

- *0115532 William Brown, A Novel Temperature Adaptive Nano-crystalline Dry Lubricant plus Hard Phase Composite Coating for Cutting Tools and Advanced Machining Applications, University of Arkansas*

Significant efficiency loss resulting from high friction and wear at the component level, and part failure leading to loss of productivity is shown to exist in industry applications. To overcome this, the researchers participating in this project have conducted an investigation of lubrication applications and shown improvements using nanoparticle-based organic composites engineered at the nano-scale. In earlier research, chemical colloidal processes have shown that nano-particles can be added to organic oils for lubrication. However, the use of colloidal lubricants leads to a very tight process parameter window, lacks efficiency in large-quantity production, and lacks ability in retaining composition. Also, for advanced lubrication applications, for example, in machining and other manufacturing operations, it is critical to achieve bonding between the inorganic nanoparticles and the organic media. A mechanical ball milling process was selected to (a) create nanoparticles of molybdenumdisulphide (MoS2) using off-the-shelf micro-particles as the starting material, and (b) in situ processing to create an inorganic-organic composite usingMoS2 nanoparticles and organic oil molecules. The starting MoS2 average micro particles size was 600 nm, which results in an average nano-particle size of less than 100 nm capped with an active lubricant layer. This offers an opportunity to synthesize nano-particles of solid lubricants to effectively address friction and wear when engineered at the molecular level as an additive emulsion.

Resilient and Sustainable Infrastructures Cluster

- *0902264 Andrew Kennedy, SGER: Waves and Surge during Hurricanes Gustav and Ike University of Notre Dame.*

This project has provided unique time series coastal wave and surge data for Hurricanes Ike and Gustav, the most comprehensive coastal hurricane wave dataset ever taken, as well as comprehensive structural damage surveys in the Bolivar Peninsula for Hurricane Ike. This data is desperately needed by the numerical modeling community, whose models have outrun the

available data, in order to provide models to plan for future storms and to provide links between direct hydrodynamic forcing and observed damage.

In addition to the intellectual merit, this project included undergraduate research from two Notre Dame undergraduates, and collaborations between three universities and four governmental agencies.

- *0830422 Ahmed Elgamal, NEESR-II: A Seismic Study of Wind Turbines for Renewable Energy, University of California San Diego*

This project analyzed results from a pilot shake table experiment on an actual 23 m high 65kW wind turbine. The result was a simple procedure to model turbines for seismic loading applications. The goal of the overall research project is to to define scenarios where seismic hazard becomes a main factor in the design considerations for wind turbines. With heights approaching 150 m, these very large structures may be seismically vulnerable in specific situations (certain earthquake magnitudes, fault types, and proximity to fault zones).

Wind turbines are a major source of Green Energy and more reliable and economical deployment of wind farms in seismically active zones will provide energy in seismically active geographic locations worldwide.

- *0324444 Roman Hryciw, Characterization of Complex Soil Stratigraphies by VisCPT and Adaptive Remeshing, University of Michigan*

Research results present valuable translational outcome using cross-disciplinary application of medical imaging to geotechnical engineering. Research purpose of locating, characterizing and estimating the strength of thin anomalous layers in a soil stratigraphy has been developed. The method utilizes finite element simulations of standard cone penetration across thin layers of varying strength with in-situ identification of their precise thickness and location using the Vision Cone Penetrometer (VisCPT). The VisCPT captures continuous images of a soil with depth through a sapphire viewing window as the penetrometer advances through the soil. Through newly developed image processing algorithms, a mathematical wavelet decomposition index was introduced and related to the dominant soil grain size in image pixels per average grain diameter. The FEM simulations utilizing adaptive remeshing reveal the CPT tip resistance signature across thin layers. For layer thicknesses less than about 30 to 50 cm, the CPT tip resistance was shown to be affected by the overlying and underlying soils and therefore will not develpo a steady value representative of the layer. Thus, misclassification and misestimates of strength are common in stratified soils. The present research develops correction factors for the effective angle of shearing resistance. The correction depends on the layer thickness which may be determined precisely by the VisCPT. This allows for proper classification and correct determination of strength for even thin layers of soil.

Systems Engineering and Design

- 0550651 Xiaobo Tan, SGER: A control oriented model for ionicpolymer-metal composite actuators, Michigan State University

Dr. Tan and his students have developed models for integrated sensory feedback for artificial muscles. This project is a good example of studying dynamic natural systems that may lead to breakthroughs in the design of engineered systems. Artificial muscles are made of ionic polymer-metal composites (IPMC), which are an emerging class of soft and resilient smart materials that produce large deflections (bending motions) under low voltages. Mimicking

biological muscles, IPMC actuators can potentially be used to perform sophisticated manipulation tasks, such as capture and transport of cells in biological studies, and assembly of complex micro and nanostructures in micro and nanomanufacturing. Precise feedback control of an IPMC actuator is required to deliver the right displacement and force output without causing any damage to the delicate objects being manipulated. The project has produced an innovative methodology for simultaneous actuation and sensing of IPMC actuators. The developed IPMC/PVDF integrated sensor/actuator has been used in micro-injection of living Drosophila embryos. The sensing strategy and model developed enable integrated sensing and control of artificial muscles, which will allow dexterous, precise, reliable, and safe manipulation of small and delicate objects in biological studies and micro/nanofabrication.

- *0510266 Noel Perkins, Mechanics and Materials Cluster: Long spatial time scale dynamics of DNA supercoils: theory and experiment, University of Michigan*

Dr. Perkins and his students have developed a computational model that can simulate the formation and structure of DNA loops and super coils. While the chemical composition of DNA and its effects on biological processes have been known for over 50 years, it is not known currently how the structure of DNA affects its biological functions. The researchers determined how these loops and coils form, what energy is required for their structural formation and their thermal stability using both experimental and theoretical methods. Understanding the structure of DNA has long-term implications for basic science and medicine. This project is important because it opens up opportunities for new genetic therapies or drug delivery mechanisms through an understanding of the mechanical structure of DNA for certain applications.

- *0301312: Sookie Bang, Performance of Microbiologically Enhanced Concrete Structural Elements, South Dakota School of Mines and Technology*

Cracking of concrete is an inevitable phenomenon and remediation of cracks has been the subject of research for many years. While there are many available products, such as structural epoxy, resins, and epoxy mortar used as filling agents to repair these cracks, none of these are environmentally friendly or safe for human health. Additionally, conventional repair materials do not always match the color of the original material. For these reasons, conventional epoxies and resins cannot be used to repair cracks in sensitive structures such as historical monuments like Mount Rushmore. This research team is investigating a novel means of crack remediation using the microbial concept of biomineralogy, the science of precipitation of minerals by living organisms. We note the use of glass/bacteria mixtures that mimic and improve upon nature in depositing inorganic filler in cracks, so the structure self-repairs.

- *0548815 Sudipta Seal, Vacancy Engineered Rare Earth Oxide Coatings for High Temperature Applications, University of Central Florida*

The issue here is that high temperature applications – such as components for jet engines – require materials that retain mechanical integrity in very severe operating environments. This work investigates novel nano-scale coatings that, when applied to materials, prevent damage caused by high temperature stresses. The coatings are made of nano-structured rare earth elements. The research team found that the coated samples of steel showed a 90 percent improvement in oxidation resistance compared to uncoated and standard micro-structured coatings. The coatings are active in the prevention of heat-based oxidation due to their unique chemical structure. Based on this favorable result, the team is developing a novel surface engineering approach to manufacture these surface engineered high temperature coatings.

B.2 OUTCOME GOAL for Learning: "*Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.*"

Comments:

The COV commends the research being funded by the CMMI as successfully cultivating a future workforce. The following funded projects were identified as exemplary examples of activities that support NSF goals for learning. The summaries were developed from highlights collected by NSF from the PIs.

Advanced Manufacturing

- *0600317 Yvonne Akpalu. Advancing the Engineering Design of Bionanocomposites to Control Properties, Rennselear Polytechnic University*

Why Plastics? is a K-12 educational science and engineering curriculum for promoting early careers in science and engineering. In the winter of 2005, Dr. Yvonne Akapalu, Assistant Professor of Chemistry and Chemical Biology at Rensselaer Polytechnic Institue developed the *Why Plastics?* curriculum to provide a high-quality educational experience in science to students at the elementary and middle school level. She designed a set of lessons to encourage students to pursue science and engineering careers through hands-on activities in polymers and plastics, cutting-edge scientific experiments, enrichment activities and effective mentoring. The *Why Plastics?* curriculum is comprised of five lessons (Polymer Exploration, What Makes Plastics Different?, Finding out What Plastics are Like, How are Plastics Products Made?, and Let's Make a Plastic!) that are designed to harvest the natural curiosity of children to make learning science "cool" and "fun" while teaching skills for success in science, engineering and technology careers. A unique quality of these lessons is that the content of each of the lessons fulfils at least four (A-Science as Inquiry, B- Physical Science, F- Science in Social and Personal Perspectives, G- History and Nature of Science) of the seven National Science Standards for elementary and middle school students. Why Plastics? courses have been an inspirational success. To date six Why Plastics? classes have been offered. These efforts have had a positive impact on over 130 pre-college students who have participated so far, the 24 undergraduate and graduate students who have served as teachers and mentors, and the faculty and community leaders who have been involved.

Dr. Yvonne Akapalu, the RPI professor who developed the Why Plastics? curriculum, is an African American female. She provides great energy and inspiration to the elementary and middle school students and to the college undergraduate and graduate students who participate in the program as mentors. A significant percentage of the students who have participated in the program are from underrepresented groups in science and engineering.

The Why Plastics? curriculum will benefit society by creating a greater reservoir of young U.S. citizens who are eager to pursue careers in science and engineering

- *9413880 Allen Soyster TRP: The Manufacturing Engineering Education Partnership Pennsylvania State University*

In 1994, under a Technology Reinvestment Program (TRP) award, a team consisting of professors from Pennsylvania State University, the University of Washington and the University of Puerto Rico, together with the Sandia National Laboratory began the creation of an

educational program to create an alternative core program in undergraduate engineering education in manufacturing. The curriculum that resulted is built upon the concept of students producing prototypes in a Learning Factory. Student teams compete for internal funding to build a product on time and budget, much as they would be challenged to do in a firm. A major goal of the activity was to attract women and minorities into manufacturing engineering. Resulting from this TRP award, a Product Realization curriculum was developed with shared pedagogy across the participating institutions. The Penn State team assembled the Learning Factory team and Industry Advisory Board, and provided administrative leadership for the partnership. The University of Puerto Rico led the dissemination workshops and assessment activities. Together, the team created a practice-based engineering curriculum that integrates theory with practice in a business framework, provides students with hands-on reinforcement of engineering principles learned in the classroom, provides an opportunity for close collaboration with industry in the education of manufacturing engineering students, and offers wide dissemination to other institutions. The curriculum includes an interdisciplinary capstone design challenge. In 2006, the National Academy of Engineering selected the Learning Factory team as the recipients of the 2006 Bernard M. Gordon Prize. This prize, one of the highest tributes for accomplishment in engineering and technology education, carries a monetary award of $500,000 to the recipients.

This work is notable because this project provides a unique educational experience for undergraduate students, particularly in the area of manufacturing engineering, and with a particular emphasis on attracting women and underrepresented minorities.

Resilient and Sustainable Infrastructures Cluster

- *0830897, James Hanson, USUCGER Workshop 2008: Research and Education Priorities for the Geotechnical Engineering Community; Sacramento, California; May 15, 2008, Cal Poly State University Foundation*

The 2008 USUCGER Workshop on Research and Education Priorities for Geotechnical Engineering provided an opportunity to establish the current status, prevailing trends, and future opportunities in geotechnical engineering. The workshop brought together leading researchers and educators in geotechnical engineering. Geotechnical engineering practitioners and federal agency representatives (Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission and National Science Foundation) also participated in the workshop to provide the state of the practice and input towards developing research priorities. The workshop provided an effective venue for face-to-face interactions and opportunities for structured and open discussions among the various stakeholders. The academicians and practitioners together provided a broad basis for discussions related to advancing educational initiatives in geotechnical engineering and related fields.

Specific workshop activities functioned to explore incorporating knowledge from other disciplines on emerging industries (biotechnology and energy issues) into geotechnical engineering research. Education and research priorities were established for geotechnical engineering and related fields.

This project had impacts beyond those to the immediate workshop attendees. Advancements in geotechnical engineering provide improved safety and functionality of infrastructure, better environmental protection, and overall improved the well being of the public at large. Presence of the workshop materials on the USUCGER website (www.usucger.org) assures broad dissemination for long-term benefits in strengthening U.S. education and research related to geotechnology.

- *0742806 Cherri Pancake, Inundation Science and Engineering Cooperative (F66) Oregon State University*

Water provides the basis for life, but can also become destructive floods, storm surges, and tsunamis. Although their damage can be mitigated, current measures are limited by our incomplete understanding of the phenomena and the impact they have on landforms, structures, lifelines, and other objects in their paths. The issues are complex and involve scales ranging from thousands of kilometers to micro-scale turbulence; consequently, there is no comprehensive model addressing even a single type of extreme inundation event. Developing a model that accurately portrays inundation and its effects on the surrounding environments will require a concerted effort involving an entire community of researchers in a broad spectrum of disciplines.

This project established the Inundation Science & Engineering Cooperative (ISEC) to facilitate community-based development of complex models. Although the seed grant was intended just to provide a prototype of the future cyberinfrastructure (CI), the PIs leveraged funding through partnerships with NACSE and ARSC and by adopting software components from the open-source community. At this time, ISEC's CI includes: workshops clearinghouse; experimental facilities clearinghouse; funding opportunities clearinghouse; models repository housing 3 community codes for shared use; 2 working groups; 5 public discussion groups; and two collaborative research projects. A rudimentary version of the data repository will open in summer 2009 in conjunction with a formal ISEC workshop.

The PIs have created an engineering virtual organization to promote and facilitate the collaborative development of complex, multi-scale models for the impact of inundation on natural and man-made environments. In doing so, they explored how to facilitate the processes that underlie collaborative research: how researchers identify mutual interests, find appropriate collaborators, share data and models, and deal with the mechanics of collaborating with people from remote institutions.

Mechanics and Materials Cluster

- *0318907 Wing Liu, Summer Institute on Nano Mechanics and Materials. Annual since 2003. Northwestern University*

Since 2003, more than 370 professors, post docs and others have participated in the NSF Summer Institute on Nano Mechanics and Materials. In 2005 there were 92 participants. This effort, funded by the CMS Division, plays a key role in workforce development in an important emerging area. It provides access to specialized courses in nanotechnology not available at many universities and stimulates the development of new course materials. Designed to be accessible to students with a BS degree in engineering, the courses provide an opportunity for students and researchers at many levels to enhance their understanding of frontier areas in nanotechnology. The courses also play a key role in promoting research collaborations and providing mentoring to students. It also has a snowball effect in that faculty members who enrolled in the Summer Institute will be able to teach what they learned to their students at their own universities.

- *0600317 Yvonne Akapalu, Advancing Engineering Design of Bionanocomposites with Controlled Properties, Renselaer Polytechnic Institute*

This African-American female Assistant Professor of Chemistry and Chemical Biology developed in 2005 the *Why Plastics?* curriculum to provide a high-quality educational experience in science

to students at the elementary and middle school level. She designed a set of lessons to encourage students to pursue science and engineering careers through hands-on activities in polymers and plastics, cutting-edge scientific experiments, enrichment activities and effective mentoring. This is designed to harvest the natural curiosity of children to make learning science "cool" and "fun" while teaching skills for success in science, engineering and technology careers.

B.3 <u>OUTCOME GOAL for Research Infrastructure: "</u>*Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools."*

Comments:

The COV finds that the research being done in the CMMI has successfully developed the Nation's research capability through the critical development of advanced instrumentation and other infrastructural tools. The following funded projects were identified as exemplary examples of activities that support NSF goals for the development of research infrastructure. The summaries were developed from highlights collected by NSF from the PIs.

<u>Advanced Manufacturing</u>

- *0084865 Chia-Hsiang Menq, Information Aggregation of 3-Dimensional Coordinate Data and Multiple-Sensor Planning for Agile Metrology and Precision Manufacturing Ohio State University Research Foundation*

This work is notable because this research provides a tool for metrology and precision manufacturing. The objective of the research is to develop information aggregation technologies and automated sensor planning algorithms that support information automation of multiple-sensor integrated systems for agile metrology and precision manufacturing. 3D coordinate points were processed in real time to extract high-level geometric abstractions, including feature geometry and feature topology. These geometric abstractions provide the global information that can be used either to locate objects and to control critical dimensions, or to form a preliminary description of the surface geometry and feature topology of an unknown object. The obtained preliminary description of the object can be subsequently used to locate the most informative view of the vision system, to guide the contact probe for rapid coordinate data acquisition, and to strategically control the coordinate measuring machine for high precision sampling of a critical surface area. The integration of the technology into manufacturing equipment will lead to the development of a fully automated, high speed, high precision, 3D coordinate acquisition system for rapid surface digitization. The resulting system can be integrated into precision manufacturing processes for part localization and real-time calibration, and for the control of critical size, location, and precision dimension. It will have potential applications in a wide spectrum of manufacturing problems with a major impact on metrology, dimensional control, and reverse engineering.

<u>Resilient and Sustainable Infrastructures Cluster</u>

- *0219123 Richard Finno, Collaborative Research: A Joint NU-UIUC Project for the Development of New Integrated Tools for Predicting, Monitoring and Controlling Ground Movements due to Excavations, Northwestern University*

The work in this project addresses an expensive problem in urban construction - ground movement caused by deep excavations. It involves real-time sensing, numerical analysis and

development of new instrumentation to allow continuously-updated predictions of ground movements so that adjustments to construction procedures can be made in a timely fashion. The PIs have applied this automated approach at the excavations for the Ford Research Center in Chicago and the addition to the Museum of Fine Arts Building in Boston. They have deployed an autonomous, remotely-operated total station to measure lateral movements and settlements and installed and operated web cameras to allow construction progress to be remotely monitored. They established project websites for interested parties to display the total station, in-place inclinometer and web camera images. The excavations were completed successfully with movements that were less than the maximum specified values. The developed approach has been adopted by STS Consultants, Ltd. when designing the excavation support system for the Block 37 development in Chicago and GeoEngineers, Inc. when designing the excavation support system for the Olive 8 project in Seattle.

The project developed tools and procedures that advanced the state-of-art and practice in the underground construction industry so that underground space can be created in urban areas in such a way that the process will have minimal impact on adjacent structures and utilities. It addresses fundamental issues regarding stress-strain behavior of natural clays at very small strain levels, self-adaptive models of soil behavior, and the relationships between detailed soil and structural responses due to construction activities. The tools include integrated analyses and information platforms to facilitate communication among engineers, contractors, owners and the public.

- *0529903 John van de Lindt, NEESWood: Development of a Performance-Based Seismic Design Philosophy for Mid-Rise Woodframe Construction, Colorado State University*

In November 2006, researchers conducted the world's first earthquake simulation of a full-size, typical wood frame townhouse using the dual shake tables at the University at Buffalo, SUNY. This facility is part of the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES). NEES is a NSF-funded shared used infrastructure with 15 experimental facilities. The two-story, three-bedroom, two-bath, 1,800 square foot townhouse was completely furnished, down to the car in the attached two-car garage, two water heaters (one anchored, according to earthquake protection measures, and one not anchored), and dishes on the dining room table. The townhouse was subjected to the severe ground motion experienced during the 1994 Northridge, California earthquake, which caused damages totaling $30 billion. Sensors and video cameras captured data about the behavior of each component of the structure. During the largest shaking of the test, researchers for the first time observed a structure's rocking motion, which reduced the seismic forces and prevented the house's collapse. More than 80 percent of the housing in the United States is wood frame construction. The results provide new insights for improving design and construction of wood frame structures, making them more resistant to seismic activity and enabling the construction of larger and taller wood structures in seismic regions. This test is part of a larger collaboration involving researchers in the United States and Japan. In 2009, a six-story wood frame structure pre-fabricated in the United States will be shipped to Miki City, Japan to be tested on the world's largest shake table. Primary Strategic Outcome Goal was Discovery to foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering. Secondary Strategic Outcome Goal was to build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools.

- *042034 Mehdi Saiidi, Seismic Performance of Bridge Systems with Conventional and Innovative Materials, University of Nevada Reno*

Researchers at the University of Nevada at Reno (UNR) in cooperation with several other universities in the U.S. and abroad developed means to examine the performance of entire four-span bridges along with the performance of individual bridge components. This system is the first of its kind capable of examining the interactions between these components, which in turn determine the performance of the entire bridge system. Such research is critical in light of recent events such as the Minneapolis Interstate 35W bridge collapse and other past earthquake related failures to ensure that the nation's infrastructure is resilient in the face of natural hazards and will maintain its ability to function safely over its life span.shake table.

The research involved with this project provides knowledge to improve design criteria and seismic codes to ensure improved bridge performance in future earthquakes. Such advancement has a major benefit to society since better bridge construction will help protect lives during seismic events. Additionally, improved bridge performance following significant earthquake events will enhance emergency response and recovery efforts after an earthquake, reducing the economic loss and loss of life that are the consequences of bridge failure.

Systems Engineering and Design

- *0555513 William Messner and Phillip LeDuc Microfluidic system for spatiotemporal investigations of cellular dynamics, Carnegie Mellon University*

This research has successfully demonstrated the use of a pressure control system for rapid and accurate control of the location of the interface between two stable layers of liquids with different chemical compositions, in a microfluidic network. The technique can be generalized to include multiple inlet and outlet streams, and network topologies with multiple streams. This system is used to study spatiotemporal characteristics of cellular behavior by selectively stimulating parts of cells in a time-varying manner though exposure to the two laminar streams. This system provides new research infrastructure for biological research. This work has led to new discoveries about the control of fluid flow in microfluidic networks, and will lead to new discoveries in cellular dynamics. The development and testing of this system requires knowledge of several diverse disciplines, and thus has motivated the team to learn about several areas outside of their previous expertise.

- *0427951 Anbo Wang SIRG: Highly multiplexed optical fiber sensing networks for infrastructure monitoring, Center for Photonics Technology (CPT) at Virginia Tech University*

This research has developed a sensor system that is small enough to be embedded into a single optical fiber in large quantities, potentially up to several thousand, for more accurate real time monitoring of various civil and industrial infrastructure systems. Real-time monitoring of infrastructure is critical to ensure against catastrophic failure and to predict any other issues that may affect their reliability. This sensor scheme was developed using advances in optical fiber manufacturing and signal processing. The developed ultra-short interferometric sensor technology results in a revolutionary increase in sensor multiplexing density for large area coverage of physical parameter measurements with high spatial resolution, harsh environment capability, and reduced cost. Such capabilities will permit real time monitoring of critical civil and industrial infrastructure both for future economic growth and homeland security.

Mechanics and Materials Cluster

- *0301140 Billie Spencer, Agent-Based Approach to Smart Sensing for Health Monitoring of Civil Infrastructure, University of Illinois at Urbana-Champaign*

This distributed structural health monitoring (SHM) system provides the enabling technology to create a densely instrumented smart sensor network for civil infrastructure. A dense sensor network is required since damage is a local phenomenon meaning sensors far from the damage locale provide little information about the damage. The benefits of the SHM system are increased public safety and reduced repair costs of the aging structures in widespread use today. In addition, the researchers formed a collaborative partnership with Intel and international researchers.

- *0424141 Fu-Kuo Chang, Identification of Anomaly in Structures Based on Locally Controlled Dynamic Inputs, Stanford University*

This researcher has developed a technique that allows structures to detect and monitor the growth of cracks and other forms of structural damage. The approach uses built-in actuators that send acousto-ultrosonic waves to sensors that allows them to identify the type and size of the structural defect. The actuators are contained in distributed active sensors networks that are built into the structures. Digital images of the defects can be downloaded and trasmitted from the site, allowing remote inspection and monitoring. This reduces the cost of inspections and reduces the incidence of accidents.

PART C. OTHER TOPICS

C.1. Please comment on any program areas in need of improvement or gaps (if any) within program areas.

The CMMI division was established in 2006 through the merger of the CMS and DMI divisions. Since then, the division's programs have changed very little. The COV recommends that the division regularly consider whether the current programs adequately support the mission of the division and how the programs and focus areas can evolve to address important national and societal issues (e.g., health care reform, energy sustainability, next generation transportation, infrastructure). The COV believes this activity would help the division align with and advance developing national priorities as well as better articulate the importance of the division's research investments to the Foundation.

The COV believes that this activity will help to further stimulate interdisciplinary collaboration between programs. The COV views focus areas such as the nano and biomechanics area, with review panels made up of experts from multiple disciplines, as a model for productive cross-disciplinary collaboration. This paradigm might be used across the division's programmatic areas as a successful strategy to disrupt program silos and seed interdisciplinary research on focus areas.
In light of the division's expanded mission, the COV recommends that an assessment of the CMMI Grantees' Conference be undertaken to identify clearly the benefits achieved by the meeting and to examine alternate formats to better achieve its goals. The division should ensure that program directors have adequate resources to interact with their PIs and to stay engaged in their disciplinary areas.

C.2. Please provide comments as appropriate on the program's performance in meeting program-specific goals and objectives that are not covered by the above questions.

The COV finds that the Division is responsive to its communities and that the projects supported by all programs demonstrate that the Division supports National goals.

To improve their ability to meet goals and objectives, the division's mission statement should be sharpened. It should be succinct and the connection between vision, mission, goals, and objectives should be clear. Without this clarity, it is difficult to define metrics for determining whether progress is being made toward meeting objectives and goals.

Additionally, the COV strongly recommends that the Division develop a strategic plan; this plan should be supportive of the overall NSF vision and mission, and its goals and objectives should speak specifically to how the Division supports National priorities. Once this plan is developed, emerging areas defined by program directors should be aligned accordingly.

The Division is at a critical juncture in its reorganization. A clear mission and strategic plan would help define the Division's identity and communicate its identity to others. This should be a top priority for the new CMMI Division Director.

C.3. Please identify agency-wide issues that should be addressed by NSF to help improve the program's performance.

The decision ***process currently used by the Foundation in making budget allocation to the directorates appears to lack transparency.*** The Foundation should clearly communicate the criteria used in making budget allocation decisions to all stakeholders. Does the current process

consider directorate and division performance in making budget allocation decisions? Incentives should be provided to encourage and promote greater directorate and division performance. This would require a clear definition of the metrics for evaluating division and directorate performances. In the current system, it is not obvious that such criteria for program, division, and directorate performance evaluation exist. It is recommended that the Foundation develop evaluation criteria and integrate the outcomes of program, division, and directorate evaluations into budget allocation decisions.

It is the Committee's assessment that ***greater contacts between program directors and their research communities would enhance their effectiveness*** in communicating the priorities and directions of their research programs as well as gathering valuable program information. Doing this would require greater travel by program directors to both current and future research investigators all over the country. However, the Committee noted that program directors who are permanent employees of the Foundation are severely constrained by budget to make such travel. To promote the programs, it is necessary that more travel funds be made available to program directors that hold permanent employment with NSF. The current dichotomy between program directors who are rotators and non-rotators in travel fund budget should be eliminated.

In reviewing the proposal jackets, the Committee noted that proposal reviewers appear unsure of what the broader impact criterion is. This is supported by the disproportionate number of reviewers who provided far less details on this criterion relative to criterion 1. To lessen this problem, the Committee recommends that NSF should provide ***a better description of what they mean by broader impacts and how they are used.*** Perhaps, one way to approach this is for the Foundation to extend the model it used in defining and communicating to its constituents the broader impacts of its own research portfolio.

Engineering ranks second to the last in proposal success rate and average award size among the directorates. Given the potential contributions of engineering to economic competitiveness and other areas of critical national needs, these statistics suggest there ***is a dichotomy between the national priorities and the budget allocation to engineering to address these needs***. What is the Foundation planning to do to eliminate or on the minimum, lessen this dichotomy? The Committee is concerned that many highly rated proposals go unfunded in engineering for lack of funds. Unfunded highly rated proposals represent missed opportunities to the nation.

Question A.3 (9) asks whether a program portfolio has an appropriate balance of institutional types participating in the program. It is difficult to adequately respond to this question when no data is shared with the Committee on what the Foundation's targets for institutional balance are. Has the Foundation ***defined or established the desired target levels that it would like to achieve on the degree of participation by various institution types*** and if so, what are these target levels? The Foundation needs to share these targets with the Committee and the program directors.

C.4. Please provide comments on any other issues the COV feels are relevant.

The COV notes that the 2006 merger of the CMS and DMI Divisions into the CMMI is still in progress. The COV recommends development of a tactical plan for completion of the integration and for assessment of the benefits of this new structure.

The COV membership did not have any panel members from the social or behavioral science disciplines. As noted in the Division's plan "Research in social, behavioral, and economic issues related to natural and technological hazards is also invited" (pg. 37 Draft CMMI Division Plan: 2008-2009). The COV membership should include representatives from these disciplines.

C.5. NSF would appreciate your comments on how to improve the COV review process, format and report template.

The individual jacket review process available on-line (e-jackets) was, in general, an efficient operation. The COV feels that the following elements could greatly improve the COV review process:

1. The CMMI director should initially, give a division overview and should be available throughout the COV visit. Areas should be emphasized that directly pertain to the questions addressed by the COV.

2. More care in preparation of the document forms provided to the COV:
   a. A summary document alerting the members of the COV of the most relevant documents to download to get a fair overview of CMMI would be helpful. This is material that would have been in the visitor folders in past years.
   b. The worksheet for jacket evaluation should be made compatible with the evaluation template.
   c. A short list identifying the documents that should be downloaded for each jacket type for jacket evaluation would be helpful. Though the members of this COV eventually worked this out, such unnecessary effort should be spared this chore.
   d. An MS Word editable COV template should be available.

3. It might be appropriate to hold the COV meeting at a different time than the annual CMMI conference so that the COV could have more focused attention from the program officers and provide less stress on the support staff.

4. A senior program officer should be given specific charge:
   a. To walk through the CMMI review process to assure that people and facilities that the COV is likely to need are readily available.
   b. To assure that the COV has all documentation necessary to answer the broad questions charged of them. An example would be a mapping of how program elements map into priorities identified by CMMI.

5. Because all materials are available to the COV only over the web, the COV should have access to the Internet throughout their visit.

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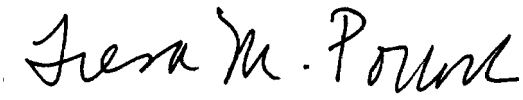

For the CMMI Division COV
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Chair